

Considered with responsibility
Recd. careful correction

Butter Williamson

EPIDEMIC CEREBRO-SPINAL MENINGITIS.

DEFINITION.—An acute disease profoundly involving the nervous system, and occurring in epidemics, characterised by painful spasmodic (or tetanic) contractions of nuchal muscles, great depression of vitality, often attended by agonising cephalic pain and apt to be accompanied by skin eruptions, generally purpuric. Lesions visible macroscopically are found *post mortem* in both brain and spinal cord.

NOMENCLATURE.—The name adopted by the Royal College of Physicians is Cerebro-spinal fever. It is often termed petechial or spotted fever: an unfortunate appellation as the disease is by no means invariably accompanied by skin eruptions. The same objection applies to the terms malignant purpuric fever, (W. Stokes) purple fever, nervo-purpuric fever (Mapother) malignant purpuræ (Tho. Swinney), pestilential purpuræ (Banks) Febris nigre (Lyons). The German titles of Nackenstarre or Genickkrampf are much better in emphasising a symptom which is probably invariable. The title cerebro-spinal fever is also a misnomer as the disease has been observed typically with no fever, or with a sub-normal temperature during its whole course.

It has also been called apoplectic typhus, encephalo-rachidien meningitis: cerebro spinites (Chaussard), and ep. neck spasm. The term given by Rodenstien—Tetanoid fever, certainly describes a prominent and probably invariable symptom, though the disease, as above stated, may be independent of any elevation of temperature.

ÆTIOLOGY.—*Seasons.*—Epidemic cerebro-spinal fever exhibits some seasonal relationship. In temperate climates the majority of epidemics occur during the cold winter, or chilly spring seasons and follow much the same seasonal curve as pneumonia. Exposure to cold has sometimes seemed to be the determining cause of an attack. Flexner and Barker (Amer. J. of Med. Sc. 1894, p. 155) record two cases of young men who after getting heated at dancing drove home one freezing night and rapidly became extremely ill with cerebro-spinal meningitis.

Latitude and Temperature.—Hirsch (New Sydenham Society Trans., Vol. III.) states its limits to be from 45° N. to 30° N. in Western Hemisphere and 63° N. (Sweden) to 30° N. in Eastern Hemisphere. This, however, is far too limited, as several epidemics in India recorded by Buchanan (J. of Hygiene, Vol. I., No. 2, April, 1901) occurred as low down as 25° while my own series were still lower at 18° and Osler records it as having occurred in the Andaman Islands, (Osler Brit. Med. J., July 24, '99). Moreover Buchanan's observations go to shew that 75% of the cases recorded in the Bengal epidemics occurred during the hot months, and my own observations accord with this, as the cases observed by myself were all during the most scorchingly hot season.

Radcliffe (Reynold's System, Vol. II) states that the geographical limits rarely overlap the isotherms of 5° and 20°. That statement is not in accordance with the increasingly large number of epidemics recorded during the past decade in India and Burmah. However from published statistics it would seem to be



almost true of Europe and America. J. Lewis Smith (Dis. of Childr., p. 363) has reported 166 epidemics found in the literature on the subject which occurred in the cold six months from December onwards and only 50 occurring in the remaining 6 months. Hirsch collected particulars of 83 epidemics and found 57 occurred in winter. Probably therefore in the Orient other predisposing factors come into play which act as powerfully as does cold and damp in the Occident.

Soil and Locality seem to have no special influence as epidemics are recorded in such widely different localities as the banks of the Lower Vistula, in the uplands of the Pyrenees, in hot damp Bengal and Burnah and in the arid dry plains of Gujerat and Rajpootana.

Sex.—Osler (Pr. of Med., p. 97) says that both males and females are equally attacked. Flexner and Barker in their account of Maryland epidemic (1893) found 37 males and 31 females attacked. Older writers incline to the view of males being more affected. Possibly this is so in certain instances where the disease appears in barracks or prisons and being contagious would naturally bring up the higher percentage among males who preponderate in such localities, and are, as a rule, more exposed to the risks of infection, as well as to such predisposing causes as cold, excesses and fatigue.

Age.—It is rare after 40, and the majority of cases are in children and young people under 25. Two of Ziemssen's cases were in patients 70 and 77 years respectively (quoted by Fagge and Pye-Smith, Pr. of Med., Vol. I., p. 659) Früs (Dissertation Copenhagen, abst; Virchow-Hirsch Jahresbericht '87, Band 2-8, 12) reports 111 cases out of 185, who were under 15 years old. In Sweden according to Hirsch out of 1,265 fatal cases he found 889 occurred in children under 15. In the epidemic at Kronach 109 cases out of a total of 115 were of ages less than 20 years. Smith (Amer. J. M. Sc., Oct. 1873, p. 320) found 771 persons under 15 years who had suffered out of a total in New York of 975 cases.

TIME OF DAY.—Several writers state that the onset is almost invariably after 12 o'clock noon. This is ^{always} not so: I have seen six typical cases which began between 6 A.M. and 11 A.M., and I know of many others.

Social conditions.—Undoubtedly crowding, insanitary conditions and famine are powerful predisposing causes, though the disease may attack mainly the strong and vigorous as has occurred in some epidemics recorded by Flexner and Barker (U. S. A.). It has been noted that very often it has begun in those barracks, poor houses and asylums which were deficient in proper sanitation and sufficiency of breathing space for the number of inhabitants.

My own series occurred during the great famine of 1899-1901 in India and were exclusively among children who were extremely weak and emaciated from months of insufficient and unsuitable food.

Possibly part of the influence accorded to seasonal occurrence is more due to the crowding and consequent unhealthy life which prevails during the colder months than to the actual climatic conditions prevalent.

It is also certain that mere insanitary conditions and overcrowding is quite insufficient in itself to cause the disease and can only be regarded as predisposing conditions. (See also Trans. of Epidemiological Soc., Vol. II., p. 369). The disease has ~~however~~ ^{never} often passed great cities where dirt and overcrowding were prevalent to crop up in some neighbouring village in a clean, wholesome farm house.

Food.—Sir B. W. Richardson in an interesting note on the disease advanced the theory that it was propagated by diseased grain, the so-called "must." (Dis. of Modern Life, Chap. 14, p. 361). No evidence has been forthcoming as to the correctness of this theory which was advanced as long ago as 1865.

TRAUMA.—This is said to be the occasional cause, and has been mentioned by several of the older writers. (e.g. Holmes and Hulke—*Surgery*. I. 696. Etc.)

Contagion.—That it spreads from the sick to the well is undoubted, but the manner and method of the propagation is by no means the same. Lewis Smith does not think it can be correctly designated as contagious (Dis. of Infancy, 6th ed., p. 360). *Direct* propagation, though supported by undoubted instances is not by any means common. Faure Villars (Recueil de Mémoires de Médecine militaire 48. 1840) gives interesting evidence of an epidemic spreading to distant parts of France all traceable backwards to a single source. Sir R. Thorne-Thorne instances a case where 7 persons in a family were attacked. It is more like influenza in its irregular, intermittent behaviour as an epidemic breaking out in some locality, and then in another quite far away and with apparently little or no connection between the two. During an epidemic the disease progresses by fits and starts. It is within my own experience that there may be an interval of several weeks between the apparent subsidence of an epidemic and the discovery of new cases occurring. Indeed its sporadic and *bizarre* methods of propagation lead one to agree with Stillé (Pepper's Syst. of Med., Vol. I.) that it is to be classed with influenza as *pandemic* rather than *epidemic*. In several cases animals seem to have been affected with similar symptoms while the disease was epidemic. (Fagge Principles of Med., Vol. I., p. 600, and Ackermann Virchow's Jahresb, 1880, I. 701).

R. B. H. Gradwohl publishes a paper from the Washington University Laboratory (Philadelphia Med. J., September 2nd, 1899, p. 445) of a case of a woman who died of epidemic cerebro-spinal fever during pregnancy and in which the *intracellularis* was recovered from the membranes of both mother and foetus. The organisms were injected into animals who also died with similar symptoms to those of cerebro-spinal fever. Herwerden (Schmidt's Jahr. Buch., 1893, Vol. IV., p. 227) gives a similar account of finding the *pneumococcus* in the meninges of mother and foetus in a *sporadic* case.

As the chief seat of the toxic agent seems to be within the cranial cavity it is natural that it should not readily be transmitted, though in some cases there are also lesions in lungs, ears, nose, etc., in which the organism may be found which is now generally regarded as causative.

Councilman Mallory and Wright say they have only found 5 instances where the disease twice occurred in the same person. It would seem therefore to establish some amount of immunity. Sir Wm. Gowers doubts however whether any true immunity is ever established.

Specific Cause.—Bacteriologists have been busy during recent years in research, to discover a specific cause. Two main opinions are now held respecting it. The *first* is that the organism of pneumonia, Fränkel's Diplococcus, or micrococcus lanceolatus, may also be responsible for inflammation of the meningeal membranes causing the symptoms observable in Cerebro-Spinal Fever.

The *second* opinion is that the specific organism, though having much resemblance to the pneumonic diplococcus is really quite distinct from it, and is the *Diplococcus Intracellularis meningitidis* first described by Weichselbaum.

Probably the *Diplococcus pneumoniae* is frequently found and can be either alone, or associated with some other organism, a specific cause of cerebro-spinal meningitis. (*Vide* Delafield and Prudden : *Path. anat.* 1896, p. 200).

Possibly its virulence is increased by association with other organisms, *e.g.*, Mosney (*La Semaine Médicale*, Jan. 4, '95) gives a series of experiments shewing its heightened virulence when mixed with staphylococcus pyog. aureus.

Leyden (*Deutsch Med. Wochenschr.* Ap. 4, '83) records the finding of diplococci having the same morphological characters as the pneumonia diplococcus in cerebro-spinal fever. Pushkareff (*Ejen klin Gazeta*, Ap. '85) and Fränkel recorded similar results obtained from the pus of a case of epidemic cerebro-spinal meningitis.

Jäger (*Zeitschrift für Hygiene* Bd. 19, p. 351 *et seq.*) found 60 to 70 % of cases recorded had *Diplococcus lanceolatus*, but all these were *sporadic* cases and he found that in the majority of *Epidemic* cases the Weichselbaum diplococcus was obtainable. (See also case by H. E. Drury, *Lancet*, Jan. 23, '00).

In 1895 Skerer stated that the organism he found in an epidemic of cerebro-spinal fever was the diplococcus of Weichselbaum. He obtained it 18 times from the nasal mucous of patients. It has also been cultivated from the pus of purulent arthritis, middle ear discharge (Schwaback) and blood of patients suffering from epidemic cerebro-spinal meningitis. It is readily got from the spinal fluid by lumbar puncture. Osler got it thus in 13 out of 16 cases.

Experimentally similar symptoms to those of epidemic cerebro-spinal fever have been produced by Netter and others on animals with the pneumonic diplococcus as well as some other organisms. Netter seems to hold (his conclusions do not seem quite clear or consistent) the view that the Weichselbaum diplococcus is a variety or an involution form of the pneumococcic organism.

Jäger (*Zeitschrift für Hygiene*, Vol. 19, 1895) discusses the proposition that the *intracellularis* is only an involution form of Fränkel's pneumococcus and regards it as very improbable, believing that the researches of Heubner (*Jahrbuch für Kinderheilkunde* 1891 and *Deutsche Medicinische Wochenschrift* 1897) have established the *diplococcus intracellularis meningitidis* as a distinct morphological entity from the *pneumococ. lanceolatus*. Banti found it in 1889 and Bonome in the Paris epidemic of 1890, Klippel found it in sporadic cases in 1891, Ribbert 1892, Welsh (John Hopkins' Report) '94, Zorkendorfer relates that he recovered the Weichselbaum diplococcus from pus in the ethmoid and sphenoidal cavities and from mucous lying on the pharynx. He inoculated rabbits which died of septicaemia, Heubner and Councilman have injected cultures beneath the spinal membranes of goats and produced the typical symptoms of the disease. Councilman Mallory and Wright ("Cerebro Spinal Meningitis") found it in 35 cases on which autopsies were made, in most of which it was found in cultures, exudate and micro-sections of tissues. It was most abundantly found in the polynuclear leucocytes.

Keifer (*Berliner Klin. Wochenschrift* '96) contracted a severe coryza followed by the symptoms of cerebro-spinal fever through inhalation of the organism. Falkiner (*Lancet*, June 23, '00) gives an account of three Germans who got acute rhinitis and nuchal stiffness while working with the diplococcus.

Beside the above named organisms the following have occasionally been discovered and regarded as causative agents:—the staph. pyogenes aureus (found by Netter in 4 out of 25 cases studied); staph. pyog. citreus (Roux. *Sur les micro-*

organismes de la meningite. Lyon Médicale 30. No. 29, p. 391); and staph. pyog. cyaneus. In a case of my own the latter was found in one specimen of spinal fluid drawn off by lumbar puncture, but I am inclined to regard it as an accidental contamination.

Mircoli found the bacillus pyog. foetid. Hanot and Livyet in 1890 isolated a streptococcus. The influenza organism and a new organism described by Centanni (1893) and called by him the *B. æorogenes meningitidis* have been ascribed as the cause.

Sherer (1894) found a pure culture of *B. coli communis* in three cases.

Mixed inflections are common. (Osler, quoting Councilman, Mallory, Wright and Netter, *Cavendish Lectures*, *Brit. Med. J.*, June 24th, 1899, p. 1518.)

To summarise; the bulk of opinion (Netter possibly excepted; his conclusions in *Twentieth Century Pract.*, Vol. 16, p. 193 *et. seq.* are not quite clear) seems to-day to accept the *Diplococcus intracellularis meningitidis* (also called *Weichselbaum's diplococcus* or *meningococcus*) as the causative agent of epidemic cerebro-spinal fever. That a primary meningitis should be caused by the pneumococcus and other organisms is quite possible and is accepted by Osler in his *Cavendish Lectures* on the subject. But probably the true epidemic cerebro-spinal meningitis is always caused by Weichselbaum's organism.

In many of the sporadic cases also the meningococcus has been found. (Geo. F. Still. *J. of Path. and Bact.*, Vol. 5, and Osler's *Cavendish Lectures*).

The table given by Osler may, I think, be taken as representing fairly accurately the prevailing opinions on the subject at present.

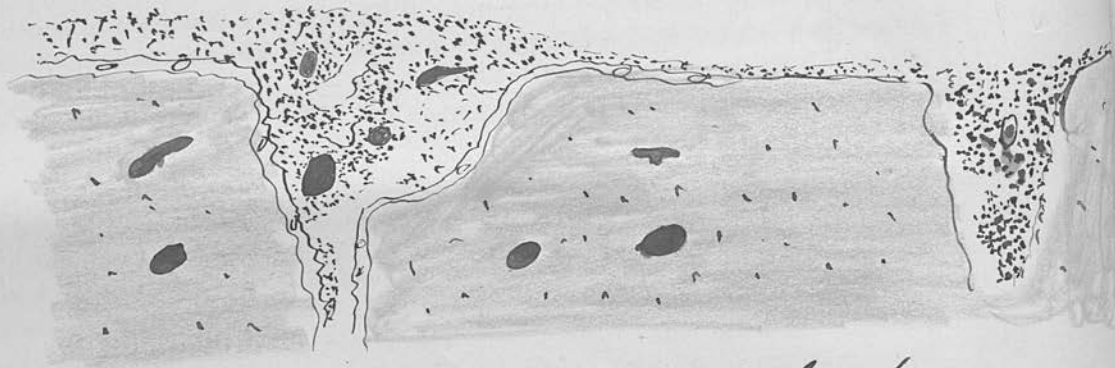
He divides Acute Lepto-Meningitis into primary and secondary.

Under the *primary* two forms are given: (a) Cerebro-spinal fever; subdivided into *sporadic* and *epidemic*, and both caused by the *meningococcus*.

(b) Pneumococcus infection.

In the *secondary* meningites a large number of organisms, *e.g.* tubercle pneumococcus, typhoid, diphtheria, etc., are given as the causative factors.

Path/and Method of Invasion.—It would seem that the causative organism often gains access to the body in the first instance through the nares and passes on thence through the cribriform plate to the meninges. This view is strongly held by Councilman, Mallory and Wright to whom we are indebted for one of the best recent monographs on the subject and is said to receive its partial proof in the fact that the *Diplococ. Intracellularis* is often plentifully found in the mucous of the nose. I have myself observed a profuse greenish purulent discharge from the nares as one of the first symptoms in 3 cases of undoubted epidemic cerebro-spinal meningitis. Eyster also has noted this. (*Med. News*, Jan. 10, '99, p. 746, see also H. Williams and Councilman: *Med. Rec.*, p. 825, June 5, '97.) The Weichselbaum organism has also been recovered from pharyngeal mucous and in a few cases (Mary Hamilton-Williams, etc.) from the peripheral blood, so that it may certainly be carried to the meninges through the blood stream. Schiff however (*Centrabltt., für. inn. Med.* 1898, No. 22) found the meningococcus in the nasal mucous of 7 out of 27 *normal* persons. This is not very surprising as the pneumococcus, etc., can frequently be recovered from normal buccal cavities. It however strikes a warning note of caution to not rest diagnosis too quickly on the discovery of the intracellularis in the nasal mucous.



Sketch of section of brain to show
dilated blood vessels & relative
amount of exudate on surface & in sub

The further invasion of the central nervous system then takes place along the following routes :—

1. Direct extension from the meninges.
2. Along the vessels from the meninges to the cerebral substance.
3. Independent foci caused by metastasis through blood stream.

W. J. Buchanan (*Journ. of Hygiene*, Vol. I., No. 2., Ap. 1901) advances the theory that dust is the usual vehicle by which the organism reaches the healthy person. He records 47 cases of which 44 occurred in persons engaged in occupations exposing them to dust.

He also draws attention to the fact that 32 of the 47 cases occurred in the dustiest season in Bengal. My own cases occurred before these observations had been recorded, but though I was not looking for proof of it I found that the epidemic occurred during the driest season when dust storms were frequent as there had been no proper rains for two years in the district. New cases ceased to occur immediately after the rains had come: this sudden disappearance of what had been a formidable epidemic excited comment at the time. Major Mactaggart (*B. M. J.*, Sept. 14, '01, p. 677) supports the dust-borne theory from his experience as Inspector-General of Gaols of N-W-P. and Oudh.

E. G. Mary Hamilton-Williams (*J. of Trop. Med.*) relates cases occurring among East African coolies in which they found the *Diplococcus intracellularis* 80 times in both sweat and blood. They suggest the former may be one of the factors in the dissemination of the disease.

PATHOLOGY.—*Rigor Mortis* is marked and prolonged. The *dura mater* is generally normal, or if at all affected, is simply inflamed and somewhat injected. In one autopsy I found the *dura* rather firmly adherent to the skull and thickened a little. Flexner and Barker say this is uncommon. I saw it studded with numerous punctate extravasations in one case. The arachnoid is rarely adherent to it. The conditions found post mortem are chiefly referable to the acute irritant action upon the cerebral and spinal meninges of the morbid agent of the disease. The pia-arachnoid of both brain and cord is acutely inflamed. Gordon (*Am. Med. Times*, Ap. 30, '64) found the arachnoid opaque at vertex in a case of only eight hours' duration. Sometimes this is the only discoverable lesion. The visceral layer of the arachnoid rests upon the gelatinous plastic purulent effusion, but is easily detachable from it, and usually fairly transparent. If, however, the disease has been rapidly fatal cloudiness of the membrane may be the prominent and only sign present of the inflammation. It is said to be more often cloudy in epidemic than in sporadic cases (*Path. Anat.* Delafield and Prudden, p. 199, 1896). There is generally a small amount of serous fluid with purulent flocculi in the cavity of the arachnoid.

The exudate on the pia is a liquid or semi-solid yellow material often seen as a white or yellowish band at first on either side of the vein and as the exudation increases the vein becomes buried in it. It may be found scattered in little islets. Sometimes it covers the convolutions as a toughish membrane. In one of my own cases the sero-purulent exudate was mainly confined to the sulci between the convolutions. Gordon describes one case where purulent exudate was found 5 hours after the onset of the disease.

I have found little clots in the larger vessels of the pia. In prolonged cases the pia may be considerably thickened and the effusion thick and cheesy in charac-

ter. In the severest cases the whole cord may be found ensheathed with it. (Loomis. *Practical Med.*, p. 713).

Usually the exudate is most abundant around intergyral spaces, at the base of the brain near optic commissure, and Pons Varolii, deep in the sulci of the cortex, specially the Sylvian fissure, and over the posterior surface of the cord, particularly, I think, its lower third. Possibly it is mainly to the recumbent position of the patient that the posterior location of the pus is due. The dura mater of the cord is often injected and thickened: contrasting thus with its comparatively rare involvement in the cranial cavity.

The cerebral convolutions may be, as in a case of my own, notably flattened from internal pressure, or from the large quantity of fluid poured out externally.

Stillé (*On Epidemic Meningitis* 1867) says he found 3 pints of fluid surrounding brain and cord in a case where death occurred on the 37th day of the disease.

I think it is fairly common to find the lateral ventricles enlarged and they may be filled with purulent fluid. (Klebs. *Virchow Archiv.* 34 Bd. 3. Heft. 1886).

In one of my cases there was considerable enlargement and the pressure within had caused the convolutions to be much flattened. The fluid however was quite clear and pus free. The choroid plexuses are either congested or infiltrated with pus and fibrinous exudate. Sometimes the inner surface of the ventricles are creamy and soft, resembling a good deal the appearance of a rotten banana. This is generally when the disease has lasted a long time. According to Klebs (*vide supra*) the subarachnoid exudate may be viscid, fibrinous, yellowish or green and contains multitudes of round granular mono-nucleated cells. It contains mucin and albuminate of soda. Meschede analysed the spinal fluid found so abundantly and says it is rich in sodium chloride, phosphate of sodium and ammonium, and oxalate of urea.

Diffuse or circumscribed areas of softening may be found in the cerebral substance (Buhl). I found one or two such areas in the medulla oblongata, in the walls of which the organism was discovered. Sections of the brain exhibit punctate extravasations of blood. Little collections of white cells are found surrounding the vessels which may give the appearance of tubercles (Flexner and Barker, *Am. J. of Med. Sc.*, February, 1894). The same may ensheath some of the cranial nerve roots and according to Councilman be found related to the Gasserian ganglion.

I have confirmed Veroshinsky's observation of the exudate extending along spinal nerve roots and cranial nerves, specially 2nd, 5th and 8th. Flexner and Barker say that where such proliferation of small round cells is seen around the nerves that the axis cylinders are more affected with fatty degeneration than elsewhere. The posterior nerve roots are more affected than the anterior. The interstitial tissue and epineurium is increased, sometimes so greatly as to obscure the nerve fibres (Strumpel). The usual cells found in exudate are polynuclear leucocytes, lymphoid corpuscles and larger corpuscles with vesicular nuclei. The large multipolar cells of anterior horn show lack of sharpness in margin: nuclei and nucleoli are obscure lying in a granulated protoplasm. The cells, in posterior horn are swollen and lymph spaces around are obliterated. The vessels in the perineurium are enlarged and there is some haemorrhage between nerve bundles. Sometimes the bundles are swollen to twice the normal, often only a faint line of myelin is seen in Schwann's sheath. There seems no constant relation between the degree of turbidity of the spinal fluid and the severity of the attack. Sometimes no cultures have been obtained from the purulent exudate in the most typical

cases, and the number of organisms found in a given series of cases does not seem to bear any relation to the seriousness of the poisoning of the nervous system.

Tiny haemorrhages may be found in the endocardium, pericardium, pleura, peritoneum, capsule of the kidney and skin. The striped muscle fibres are intensely red and hyperaemic and under the microscope show hyaline and granular degeneration.

Parenchymatous degeneration is found in the kidneys, the medulla is markedly congested, the epithelium of the tubules is granular and sometimes fatty.

Parenchymatous degeneration has also been found in liver.

The spleen is generally a little enlarged. Klebs however found it small and flaccid in a number of his cases. The lymphatic tissue of the nodules is usually increased in amount.

Fatty degeneration of the heart muscle has been met with by Buhl. It is open to question I think whether there is any proof that it is caused by the poison of the disease.

Heller says that the semi-circular canals and tympanic cavity are filled with yellow purulent fluid. The mastoids often contain stringy pus (S. V. Steen. *Arch. of Otol.*, October and December, 1899). The longitudinal sinus is filled with dark fluid blood. Thrombosis according to Gowers is rare (*Nerv. Dis.*, Amer. Ed., p. 756) but recent writers have fairly often reported it. The proportion of fibrin in the systemic blood is increased up to 6 parts per 1,000 (Ames, Tourdes and Maillot) and yet according to others the blood has unusual fluidity. The probable explanation of this seeming contradiction is found in the different types of the disease and whether the blood is examined during the early inflammatory stage or later after purulent exudation has taken place. Occasionally bubbles of gas have been found in the heart and large vessels. In the pneumonic patches which are sometimes met with in the lung, the *diploc. intracel. meningitidis* was found in the Boston (1896) epidemic. Councilman says the lining epithelium of the arteries show no change in cerebro-spinal fever but in other meningites it is inflamed and shows cellular proliferation.

Merkel states however that he has found a nuclear proliferation *within* the vessels extending from the cerebral meninges to the spinal cord, in a few cases.

Peyer's patches are swollen and seen more distinctly but there is no ulceration.

The intestinal mucous membrane shows catarrhal thickening, and the glands project like millet seeds.

There is found an increase in the number of the white blood cells, while the red are shrivelled, serrated and partly disorganised. The blood readily decomposes.

The punctate haemorrhages seen ⁴microscopically on section of the brain, are found microscopically to be minute blood extravasations, with a few pus cells. They were very marked in one of my own cases.

The spinal canal has been found dilated and full of pus (Fronmüller).

The neuroglia cells beneath the cortex cerebri are swollen and their nuclei are imbedded in protoplasm which stains badly and is slightly granular. Some cells are generally found multinuclear and karyokinetic figures are often beautifully seen. The nuclei are full of chromatin granules but are with a low power fairly clear limpid looking bodies.

The ganglion cells show some atrophy and altered staining reaction.

The sheathes of the optic (Stellwag and H. Pagenstecher) and olfactory nerves enclose a number of pus corpuscles, leucocytes with nuclei "tied to-

gether" and sometimes large epithelioid cells presenting an appearance like the "nests" in tubercle.

It has been advanced that the exudation into the third ventricle presses the fluid of subarachnoid space into the sheath of the optic nerve and so produces the dropsy found. Leber (*Trans. Internat. Med. Congress*, 1881, 3, p. 52) holds the view that the fluid is an irritant and sets up the optic neuritis found. Deutschmann (*Ueber Neuritis Optica*, Jena '87) holds the same view.

The iris has been found infiltrated with pus cells, and in the vitreous and anterior chamber the diplococcus intracellularis has been found in the pus cells. In a certain number of cases with irido-chorioiditis recovery with fair sight occurs (Niemeyer).

The spinal fluid after standing some hours usually shows some turbidity due to pus and fibrin. Some American physicians have regarded the turbidity as an index of the severity of the disease. In the cases in which I drew off the fluid it was clear, though it was not drawn off during a period of remission, when it is often clear, but during an acute exacerbation of the disease.

Morphology.—The organism of Weichselbaum is found in the purulent exudate covering both brain and spinal cord, and has been recovered from the central canal.

I was able in one case to obtain it from fluid drawn off by Quinck's lumbar puncture and also by cerebral puncture through a drill hole made over the temporal fossa. It is a diplococcus occurring in pairs shaped somewhat like cartilage cells and having a pale unstained interval between the two. They are often placed side by side along their long axis. → 00

There is great variation in the size though the larger ones ("*Pathological Technique*," Mallory and Wright, 1901, p. 149) are regarded as degenerate or involution forms.

Often they are found inside pus cells and leucocytes, and frequently within the nucleus. In my own cases they were only found in the fluid. They often are clumped together: four or six being generally the number in a group. Gonorrhoeal pus has a good deal the same appearance under the microscope as cerebro-spinal fever exudate.

In cultivation media they are more round than lanceolate.

They were found in one of my cases occasionally in chains (Jaeger and Williamson) and sometimes one of the cocci was very much larger than the other in the pair.

They are more abundantly found in the fluid at the bottom of sulci than in the brain or cord substance.

They are decolorised by Gram's method, thus contrasting with the pneumococcic organism which is stained by Gram. Occasionally, however, a smear preparation (Jaeger quoted in *Med. Record*, Aug. 14, '97, p. 245) or a culture which is mixed with streptococci does not decolorise. In the case recorded by Lazarus-Barlow, (*British Medical J.*, September 2nd, '01, p. 767) this may conceivably have been the reason for retaining Gram's stain. Cultivation is not easy and often the organisms die. In blood serum the growth generally appears in 24 hours. They are sticky, looking little greyish, colonies of about 2—3 mms., round, and with flattened or rounded top. They are not granular under the microscope.

In meat broth a sticky stringy substance rises when the tube is shaken. At rest there is a whitish sediment.

It does not liquefy gelatine and it can be grown on agar-agar, alkaline 5% glycerine-agar, sugar-agar, potato, etc.

It succeeds best on Löffler's blood serum. For rapid examination the exudate should be prepared thus: The pus is spread thinly over a cover glass and then stained with aniline violet solution for $\frac{1}{2}$ minute without heat. Wash in water. Stain with Gram's solution for same length of time and again wash with water and then 90% alcohol till all the color has disappeared. Wash the alcohol off with water and stain in Bismark brown for 30 seconds. If brown cocci are found in the pus cells it is almost certainly the organism *diplococcus intracell. meningitidis*. To preserve them transplanation is needful at frequent intervals.

Heubner found it retained its virulence longest by gelatine cultivation (Jahrbuch für Kinderheilkunde, 1891). It resists desiccation and has been found alive in a handkerchief at the end of 90 days according to Germano (Zeitschrift f. Hyg. u. Infektionskr. XXVI, p. 288, 391) and retains its virulence when in sputum or blood for at least 4 months (Flexner and Barker). It is very susceptible to aerial convection currents. Councilman, Mallory and Wright ("Ep. Cerebro sp. Mening." Boston, 1898) found that on paper the cultures resisted desiccation for 60 hours. Kamen thinks that the organisms have more vitality after they have been grown for several generations in artificial culture media (Centrabl. f. Bakteriologie, 24., p. 555).

Histologically it is found that the *intracellularis* tends to extend from the pia more deeply into the cord, and there is far more purulent exudation especially along the pial vessels than is found in pneumococcic or streptococcic infection (Foulerton Brit. Med. J., Sep 21., 763).

SYMPTOMATOLOGY.—The disease can conveniently be divided into three main types, the *foudroyant* or fulminant, the *simple*, and the *abortive*. There is also the chronic type (Heubner) but this latter is really a persistence in a less acute form of the simple. I see no reason for making the purpuric into a separate class as purpuric symptoms may be present in any of the above named and may be absent certainly in the simple, and probably also in fulminant. There is far more reason I think for putting the intermittent cases into a separate class (Hirsch Ziemssen and Stillé) though even in these I am inclined to think there is not sufficient difference between them and a large number which show some amount of intermittency to justify such classification.

In the *foudroyant* type the patient is struck down suddenly: headache is agonising: capillary stasis is seen on the surface; delirium is rapidly succeeded by coma and death occurs in 12-20 hours from onset.

Abortive cases usually present one or two symptoms (severe cephalgia and retraction of nuchal muscles most commonly) in a pronounced degree, while the remainder of the symptoms are either extremely slightly manifested or are absent entirely. Just as in other epidemic diseases such as cholera or diphtheria, the abortive cases generally occur early, before the disease has been recognised as epidemic; or late when it is subsiding.

Where such cases are associated with an epidemic and apparently exhibit some amount of epidemic character the diagnosis is doubtless quite warrantable. In the majority of instances where I have found recorded in the literature on the

subject such abortive types, I have not been able to assure myself that the disease was epidemic cerebro-spinal meningitis. Until these anomalous cases have been confirmed more frequently by pathological and bacteriological investigation one inclines to treat them with some reserve. Davidson (Dissertation Berlin, 95) says in infants only an unusual degree of sleepiness or restlessness may be observed in cases which *post mortem* show evidence of cerebro-spinal fever.

Simple type.—*Incubation period and premonitory symptoms.*

No definite incubation period has yet been assigned. In all the cases which I have seen, the onset has been sudden with only a few hours of premonitory indisposition. I think, however, usually for at least 2 or 3 days beforehand the patient suffers from neuralgic pains in the head and muscles, loses his appetite and has a growing feeling of extreme lassitude and inability to move about. J. Netter Radcliffe (Reynold's Syst. of Med., Vol. II, p. 677) thinks this incubation period may last as long as seven days. Strümpell and most other authorities agree that such a length of time is extremely rare. Personally, unless the case received unequivocal bacteriological confirmation I should regard such a long premonitory period as suggestive rather of tubercular meningitis. In children vomiting often heralds the nervous disturbance. Dragging pains may be experienced in the limbs. Constipation is usually present. There may be relaxation of both sphincters or retention of urine: catheterising the patient often causes a return to consciousness. Tongue at first is moist, then becomes coated with white fur and eventually is dry, and covered with a thick brown deposit, a good deal resembling that seen in typhoid fever, but the edges are less clean.

Clinical course of a typical simple case.—Strümpell (Deutsches Archiv. f. Klin. Med. 30) says one of the most striking features of the disease is its variability. This is undoubtedly so and yet there are some cardinal symptoms which are almost invariable.

These are :

1. Headache, intense and intolerable often accompanied by vertigo.
2. Muscular pain: generally of the neck and spine.
3. Retraction of the head and contractions ~~of~~ tetanic or otherwise, of other muscles.
4. Mental disturbance.

Whether there be long premonition or not (Sabarth Breslauer Artz. Zeitsch. '79, No. 18 gives the premonitory symptoms as "anything from 2 days to 2 weeks"!) the onset is usually notable by the acuteness of the symptoms.

1. **HEADACHE.**—After the child, for the patients are very frequently children, has been indisposed for some hours or days and has been perhaps dull, listless and vomiting occasionally, he *suddenly* complains of intense agonising headache often accompanied by vertigo. The headache is intolerable, the patient often rolling from side to side writhing with the pain. It is unrelieved by emesis. It is generally at the top of the head, sometimes at the occiput, and is boring or lancinating in character, and lasts usually during the whole course of the malady. It may persist into the period of convalescence. I have personally seen the accompanying vertigo so extreme that the child has fallen down violently as if hurled to the ground by some unseen force, as in the sudden manner characteristic of the worst cases of Mènière's disease.

Tourdes records two cases in which the patients were seen whirling around in a staggering fashion suggesting to him the probable involvement of the ampullar nerve-endings of the auditory organ.

2. **Muscular pain** is next complained of in the region of the nuchal muscles and in the spine and often also the abdomen. Gowers (*Nerv. Dis.*, p. 753) says the sacrum is often the seat of very severe pain.

3. Probably often largely as a consequence of this painful condition the **head is retracted**, and sometimes opisthotonus is found. My reason for believing that this characteristic backward pose of the head is often assumed simply to relieve the pain is that in six cases where I observed it in an extreme degree I found that the muscles at the nape of the neck were not notably hardened with the hardening characteristic of *spasmodic* contraction, but were no harder than one finds in a normal patient who voluntarily bends his head far back. In going through the literature I find Burdon Sanderson (8th Report of Medical Officer of Privy Council, p. 286) advanced the same view in 1865. In a number of cases, however, I have satisfied myself that there was a real spasmodic contraction as well, probably reflexly brought about by inflammation of the motor nerve endings in the muscles involved. The head retraction is generally an early symptom. The spine ache may be cruelly agonising. Pain, if severe, in the limbs is generally confined to the joints. The rigidity of the neck is occasionally supplanted by paralysis (Netter, 20th Centy. Practice, Vol. XVI). Usually the painful state of the muscles appears *pari passu* with mental disturbance. These muscular pains are increased by movement and the patient resents any attempt to change the posture of the limbs and head. Reynold's (*System of Med.*, Vol. II) says that pressure on the spinous processes, however, rarely causes pain. The abdominal pains are occasionally so severe as to almost constitute a separate type of the disease. My own experience seems to indicate that the rachialgia generally radiates from an exquisitely sensitive area, which is usually quite limited in extent. According to ~~the~~ Netten Radcliffe (Reynold's *System*, Vol. II) rachialgia is not present in the severest purpuric forms. Tetanic contractions of various groups of muscles may now be observed, causing trismus, squinting of the eyes, and opisthotonus or what is commoner an acute flexion of legs upon thighs. The strabismus and spasm of the face is usual brief and changing. I have noticed a certain alternation between the two with an interval of rigid facial contraction expressive of great pain. Jacksonian convulsions may be seen. In a case of my own athetosis of the fingers was observed and in another the movements were choreiform in character. This is rare, according to Gray (*Nerv. and Mental Dis.*, p. 365). The *recti abdominis* are stated to be sometimes violently in spasm and to give the impression of two cord-like bands beneath the skin. Carpo-pedal contractions are frequent.

The gullet may be the seat of spasmodic contraction. According to W. J. Class this is a symptom of grave significance. Out of 38 cases reported (Report of Chicago epidemic of cerebro-spinal fever, 1898) he found swallowing difficult through spasmodic contraction in 6 cases, all of which proved fatal. Possibly the symptom is an indication of intra-ventricular pressure causing irritation of the centres controlling the deglutitional muscles.

4. **Mental disturbance.** ^{may be} This is almost always found either as mental confusion, or an active delirium, or insensibility to sound and incapability of being roused, or as an acute violent maniacal excitement. Generally the mental con-

fusion assumes the form of a low muttering delirium, stupor supervenes from which the patient can be roused for a few moments, but resents it and speedily sinks back into a somnolent apathy. The patient's mind may be so disordered that his own mother is not recognised or another person mistaken for her.

The face reflects often the fleeting fancies of delirious pleasure, or is vacant and placid betokening mental apathy. It is usually pale and shrunken. Often when the patient is in a profound stupor the muscles of the forehead are contracted shewing the persistence of painful impressions.

The *inconstant* symptoms are:—

1. Fever.
2. Disturbances of alimentary system.
3. Hyperaesthesia.
4. Skin lesions.
5. Involvement of special senses.
6. Joint affections.

All the above-named are of course very frequent but as they all individually may be absent in one case or another I have classified them as the *inconstant* (though quite frequent) symptoms.

I. Fever.—With the early shivering or rigors there is generally associated some *fever*. Sometimes this is high, reaching 104°F. More often the temperature is not raised more than a degree or two. I have been unable to find any guide as to the severity of the illness or prognosis in the degree or character of the fever.

Three of the worst and most rapidly fatal cases I have seen, exhibited but little fever, while one boy who maintained a high temperature for 48 hours ultimately improved.

Sometimes fever is entirely absent. The character of the chart is very irregular; there is nothing I know of that can fairly be called a classical type.

Some cases have been reported (see that of D.A. Belilios, *Lancet*, July 15, '98, p. 156) in which there has been no fever or even a sub-normal temperature present, though other signs were clearly diagnostic of the disease. In one of my own cases there was a subnormal temperature. In one of my own worst cases there was no rise of temperature during the whole period of illness. Lewis Smith (*Amer. Journal of Med. Sc.*, Oct., 1873) noticed a number of years ago that in nearly all such cases the rectal temperature however shows some elevation. A number of writers quoted by Stillé (Strong, Miner, Gilchrist, and Jenks) think that an elevated temperature is a rare occurrence. Burden-Sanderson noticed that often a rise of temperature heralds an increase in the pain. It certainly often rises notably before a fatal termination.

II. Disturbances of Alimentary System.—*Vomiting* may be the initial symptom and cephalgia may follow in an hour or two. In 97 cases recorded by Lewis Smith of New York vomiting occurred as an early symptom in sixty-eight.

My own cases were accompanied by very slight enesis and it was remarkably easily controlled by the usual remedies, contrary to the general experience on this point. Von Ziemssen (*Cyclop. of Med.*, Vol. II) says that vomiting in the later stages indicates distensions of ventricles and is a bad omen.

The vomiting which may have been present as a prodrome, changes its character and instead of being occasional, scanty and accompanied by nausea, becomes profuse, persistent and often projectile and is quite independent of nausea. It is sometimes associated with a perfectly clean condition of the tongue. The abdomen is sometimes retracted markedly; I saw this in one of my own cases. The lips are covered with dirty sordes and the tonsillar crypts are often filled with cheesy material. The fæces may be at first semi-liquid, of an absinth green color. They are generally alkaline in reaction and may resemble early dysenteric stools in containing mucous and blood. The *Diplococcus Intracellularis* has been found in the dejections.

III. Hyperaesthesia.—Cutaneous hyperaesthesia is common, probably from irritation of the nerve endings. Lewis Smith regarded such hyperaesthesia as almost pathognomonic of the disease (*Amer. J. Med. Sc.*, Oct. 1873). In 3 cases of my own, there was such hyperaesthesia present that the boys could not bear even light stroking of the skin without crying out. Sometimes it is entirely absent or may be succeeded by anaesthesia. The rectal and anal surfaces may be intensely hyperaesthetic. (Lewis Smith and Lewis.) Rosenthal (*Dis. of Nerv. System*) says often the hyperaesthesia is so great that the weight of the bed clothes is insupportable, and their mere contact with the skin causes violent convulsions.

IV. Skin lesions.—1. Purpuric eruptions are so common as to have given to the disease several names denoting their presence. The purpuric rash may appear early: these may be true or purpuric mottlings, sometimes with regular, sometimes serrated margins. They may be discreet or confluent: at the onset generally red, becoming purplish or even black. They may be found all over the body or confined to the trunk or limbs only. Sometimes they are hard and seed-like to the touch. There may be a cyanotic aspect of the face which may be accompanied by true purpuric areas. Actual hæmorrhages from the mucous membranes of nose, bowel and kidney are not very rare.

2. Herpes. This may appear along with purpura, the vesicles being superimposed on purpuric spots; or as vesicular eruptions on the face or thorax as in pneumonia: often six or seven groups as large as one's hand are found; most commonly in areas supplied by 5th cranial nerve. It may occur at any period of the disease though usually from 3rd to 6th day: it seems to have no prognostic influence. In the Copenhagen epidemic the cases with herpes showed a mortality of 35·2% while those without amounted to 35·5%, or practically the same. Herpes is seen in a very large percentage of cases. Leichtenstern saw it 26 times out of 29 while V. Sydow only found it in 20% of his cases. The eruption is generally bilateral.

3. Sometimes a peculiar condition like "goose skin" due to contraction of the muscular fibres of corium has been seen before the onset of any definite eruption. Ziemssen (Fagge and Pye-Smith *Pr. of Med. J.*, 656) lays stress on the bilateral character of the skin lesions—herpes on both lips, urticaria on both wrists, or petechiae on both shoulders.

Other eruptions met with are:—

Urticaria.

Erythema.

Roseola (Carter., *Pr. of Med.*, p. 70.)

Lenticular rose spots (Tourdes.)

Sudamina.

Ecthyma.

Furuncles.

Scarletiform Eruption.

Pemphigus (Grinshaw, *J. of Cutan. Med.*, Vol. II., 37.)

Similar skin eruptions are described by Procopius and Euagrius in connection with the "plague" in Constantinople. Sir B. W. Richardson (*Dis. of Modern Life*, 1879, p. 16) thought the reference referred to what we know to-day as Ep. cerebro-sp. meningitis.

V. Affections of Special Senses:—

(a) **Eye.**—The eyes are frequently and extensively involved. The lids are swollen (Swanzy: *Dis. of Eyes*, 6th ed., p. 473) chemosis is found (Nettleship. *Dis. of Eyes*, p. 403) and conjunctivitis with sticky secretion is specially common in the early stages among children (Carmichael. *Dis. in Children*, p. 95) Hyperæmia of the conjunctiva may present such a dusky hue as to suggest that seen in typhus fever.

Photophobia is generally marked and is usually associated with tactile hyperæsthesia and hyperacausis.

The eyes are often the seat of fleeting paralyses causing strabismus (sometimes the result of a refractive anomaly according to Thomson. *Clinical Treatment of Sick Children*, p. 138) and diplopia. Nauwerck's 29 cases shew 6 with strabismus. Corbin (*Gaz. Médicale de Paris*, 1848) found some of the external ocular muscles paralysed in two-thirds of his cases and Lewis Smith (*Am. J. Med. Sec.* 1873) reports it in all his series. According to Cheatham the motor nerve most frequently affected is the abducens. (*Phil. Med. Rec.*, July 15, '99, p. 135.)

Nystagmus is not uncommon and is generally lateral. A case given by Jaffé exhibited rotary nystagmus.

Keratitis causing ulceration of the cornea may occur.

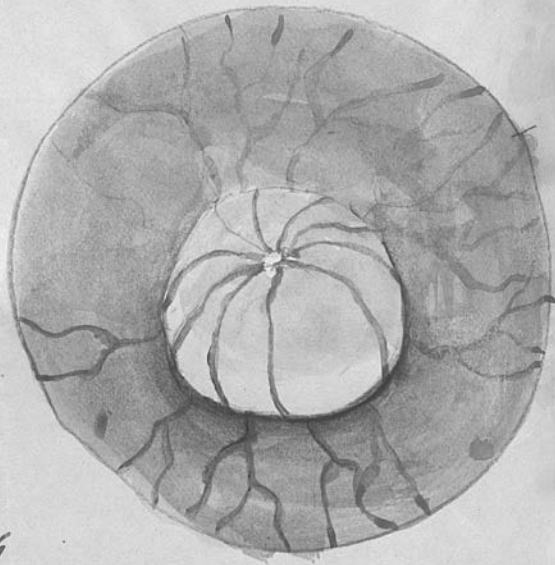
In a recent series of cases under my own observation I found the corneae of one boy markedly clouded within a few hours of the onset of the illness, a possible explanation of such clouding is the involvement of the Gasserian ganglion and so interference being caused in the trophic influence which the ganglion exerts upon the cornea. The change seemed so rapid, as to suggest a nervous cause and the hypothesis finds support in the facts that (1) the Gasserian ganglion when diseased does cause such corneal cloudiness and (2) the Gasserian ganglion is often involved in the inflammatory processes of epidemic meningitis, (Councilman, Mallory and Wright found it softened in all their cases in which it was removed). It awaits confirmation from careful microscopic examination however at present. Still deeper destructive changes may occur in the eye constituents: the lens becoming cataractous, the vitreous opaque, a purulent infiltration of choroid (de Schweinitz. *American Text Book of Diseases of Eye*, 1901, page 339) or detachment of the retina taking place.

Blindness, temporary or permanent, has been often noted. (Knapp: and Netter *Twentieth Century Practice*, Vol. 16; etc.).

B. K. Chance (*Columbus Med. J.*, Feb. 1900) found diminution of central vision.

The pupil reaction is extremely varied; sometimes the pupils are widely dilated: sometimes the aperture is a tiny black spot. Oftener they are unequal and

Sketched appearance of fundus seen in a fetal case of cerebro-spinal meningitis exhibiting "mushroom" appearance of papilla. The edges should be somewhat more "fluffy" & the papilla is drawn a little too large - though it was very much increased in diameter from a normal fundus.



changeable—the one which at one time was the smaller is found much the larger of the two a few hours later. One or both may temporally fail to react to light. In almost all cases they respond very slowly.

The iris may be pressed forward and the anterior chamber be shallow. Iritis with synechia is frequent: a large amount of plastic exudate is thrown out. Senator *Charité*, *Ann.* XI, p. 282) records many cases. Knies says the choroid and *uvea* involvement is almost always unilateral. The lens often clouds and then become cataractous.

The whole eye may be the seat of a purulent disorganisation apparently propagated from the meninges along the sheaths of the optic nerves. This rarely occurs on both sides and thus contrasts with the aural affections which are generally bilateral.

The ocular conditions bear a striking resemblance to the sequelae of plague to any one who has worked in plague areas. Almost every symptom I have seen duplicated in patients who have convalesced from plague and come into Hospital later for some eye trouble which occurred soon after the more serious malady.

Optic Nerve and Fundus.—Sometimes these exhibit great and rapid pathological changes. In one case I saw profound optic neuritis within 8 hours of the patient coming into Hospital. It was a most typical example of the classic description of the fluffy whitish yellow “mushroom” growth of an optic nerve. Leber and Deutckmann believe that the irritating property of the fluid propagated along the sheaths of the optic nerves causes the neuritis.

In many cases optic atrophy of an extreme grade has been noted, especially during convalescence. It may be present to an advanced degree without serious impairment of vision. (Noyes. *Dis. of Eye*, p. 611.) It is not easy to say whether the condition of the fundus can be taken as any criterion for prognosis. From the cases recorded I am inclined to think that patients exhibiting *rapidly developing* optic neuritis have a worse prognosis as to mortality, than cases which shew a slow atrophy of the disc. In two cases of my own where the neuritis was acute the termination occurred within 48 hours of onset. In 35 cases recorded in *Beiträge zur Kenntniss der Epid. Cerebro Sp. Mening.* (Deut. archiv. für Klin. Med. Bd. 30, s. 332) the fundus was found normal in seven. In the others (*i.e.*, 80%) there was congestion of retinal vessels and some involvement of the disc—either a neuritis or a post-neuritic atrophy.

(b) **Ear.**—Aural complications are frequent. According to Radcliffe (Reynold's *Syst. of Med.*, Vol. II) and Ormerod (Allbutt's *System*, Vol. I. p. 668) they are more frequent than affections of the eye. After going through the records of some hundreds of cases in European, American and Indian epidemics I am inclined to doubt this; at all events in the epidemics of the past 15 years. Wm. J. Class (*Med. News*, December 3rd, '98, p. 733) also says in his experience they are by no means so frequent.

Deafness may be caused by a purulent middle ear inflammation (Roosa) or inflammatory changes set up in the lining membrane of the vestibule (Deuch) and semi-circular canals (Moos. *Ueber Meningit. Cerebro-Sp. Epid.*). Just as in the purulent panophthalmitis the meningeal inflammation probably spreads along the neural sheath and gains access thus to the auditory apparatus.

Moos, (as quoted in Allbutt's *System*, Vol. I) found that out of 64 convalescents 38 were deaf mutes, 20 absolutely deaf and 5 partially deaf. De Schweinitz and Randall in their new American text-book (1901, p. 652) on diseases of eye and

ear record finding 14 per cent. of deaf mutes in Jacksonville Institute as having been caused by this disease.

Roth and Merkel (quoted by Ziemssen. *Cyclop. of Pract. Med.*, Vol. 2, p. 726) found 22 out of 33 in the Nuremburg School for deaf mutes had a history of cerebro-spinal meningitis as the cause of their deaf mutism, while in Bamberg the entire number owed their deaf mutism to the same cause. McBride (*Dis. of Throat and Ear*, p. 640) and Pomeroy (*Diagnosis of Ear Dis.*) also note the frequency of such cases.

The membrana tympani is found a dull yellowish and sometimes reddish hue. The loss of hearing is almost always bilateral. (Cf. blindness which is rarely anything but *mono-lateral*) Knapp examined the ears of 31 patients deaf from the disease and found it was bilateral in all.

The cause has been ascribed to an inflammatory lesion of the acoustic centre in the brain (Sexton "*The Ear and its Diseases*," p. 68). Whether that be so or not there is certainly sufficient cause found peripherally in the purulent inflammation of the middle ear and labyrinth to account for the symptoms without any central lesion. Moreover Gruenin has obtained normal electrical reaction from the auditory nerve within the cranium which is against the idea of a central cause. Klebs in his pathological museum at Berlin has a specimen of fibrinous adhesions having taken place between the bones of the internal ear and vestibular walls, which is probably a fairly common result of the inflammatory process in the organ itself.

(c) **Nose.**—There is frequently a profuse nasal discharge. I observed this in six patients: it was a thickish green purulent discharge. This has occasionally been so profuse as to lead to the diagnosis at first of influenza as in the 1898 epidemic in Styria.

Smell is occasionally lost. Wentworth in a paper read before Mass. Med. Soc. June 7, '98 says that it is possible the nose is one of the main channels through which the causative organism enters the system. Epistaxis is often severe (Flexner and Barker, *Amer. J. Med. Sc.*, 1894, pp. 155 *et seq.*).

(d) **Taste.**—This has sometimes been lost permanently. More often when affected (which is not usual) it is temporally lost and slowly regained during convalescence. It may be perverted (Loomis, *Pract. Med.*, p. 71).

VI. Joint Affections.—Sir Douglas Powell records a number of cases in which joint affections were found late in the disease. Kotsonopolus (*Arch. f. pathologische Anatomie*) found joint affections in all the cases of the Nauplia epidemic. There may be purulent necrosis of spinal vertebrae or serous or purulent inflammation of any of the joints, *e.g.* knee and elbow. Flexner (U. S. A.) says that 20% of his cases had joint affections. In 111 cases, however, recorded by Councilman Mallory and Wright, only 6 shewed arthritis. The arthritis may be mono- or poly-articular. The joint is usually red, swollen and painful (Collins. *Quart. J. of Dublin*, 1868, p. 170). Even passive movement elicits considerable pain.

Still (*J. of Path. and Bacteriol.* V. 1898) records a case in which he found the diplococcus intracellularis in the purulent fluid of the joint. Recovery is happily the rule in these arthritic complications.

Genito-Urinary System.—Fatty and fibrinous casts and sometimes a few blood corpuscles (Aubrey Husband, *Pr. of Med.*, p. 67) are found in the urine. In the rapidly progressive fatal cases albumen is present and the urine is poor in

chlorides and rich in urates. Stillé says that sugar is also occasionally present. Polyuria and Mellituria have been observed by Ziemssen, Mannkopff and Hasse but are rare. Mosler gives a case where 4 years after an attack the patient was still suffering from polyuria. In a case of my own which recovered, there was polyuria for some time afterwards. Usually, however, the amount secreted is no more than normal. Priapism has been recorded. (*Lancet*, Nov. 6, '97, p. 1185). Marked erotic symptoms are sometimes seen early in the disease and the delirium may take on a pronouncedly sexual character. Micrococci have been found (? *diplococcus intracellularis meningitidis*) in the urine (Gandier: *Rev. Médicale*, June 3, 1882).

Reflexes.—A remarkable symptom first described by the Russian physician, Kernig, is found in connection with the joints and is called Kernig's sign. (*Neurolog. Centralblatt*, 1884, p. 391). When the patient's knee is flexed on the thigh and then somewhat suddenly extended a spasm is induced in the muscles preventing full extension from taking place.

Or if the patient is made to partially sit up in bed, the leg immediately assumes a flexed posture and on attempting to extend it, spasmodic resistance is encountered. The same may occur in the upper limb (W. J. Buchanan, *Brit. Med. J.*, Feb. 3, '00, p. 255). Jas. Barr (*Treatment of typhoid fever*, p. 120) notes a somewhat similar occurrence during typhoid and also says (*Brit. Med. J.*, Mar. 24, '00, p. 700) he has found it in meningitis consequent on middle ear disease. The paragraph above named is obscure and it seems very doubtful if it was a true Kernig's phenomenon as no mention is made of the *spasm* induced but only that extension caused *pain*.

However, the sign is not always pathognomonic as Galli (*Riv. Crit di Clin Med.* Oct. 20, 1900) relates he has found it present in 88% of cases of meningitis of all kinds. I have met with one interesting case of a low caste Hindu who presented the typical Kernig's phenomena along with spastic paralysis. There was no history obtainable of previous meningitis of any kind whatsoever.

Its presence is no index of the severity of the case. Netter has explained the phenomenon as being due to irritability of the nerves which is still further heightened by putting them on the stretch by flexure of the thigh and they then abnormally respond and cause overaction of the muscles when extension is attempted.

The knee jerks are sometimes absent temporally and sometimes increased. Several authorities say that generally there is some exaggeration of the knee jerks and other reflexes. Strümpell found them absent altogether in five out of 35 cases examined. They may disappear and again return. I have found no mention made of the extensor response of the great toe, the plantar reflex, nor the cremasteric reflexes. I do not know whether they are in any way modified by the disease.

Respiratory System.—The breathing is usually slow and labored at the beginning and may, as in two cases observed by myself, become stertorous. Generally at the last it is hurried, shallow and difficult.

I have observed a moaning respiration in three cases, quite like that found in pneumonia though there were no associated pneumonic symptoms. In one case I watched Cheyne-Stokes breathing develop shortly before the end. From the records (which, however, are rather scanty on this point) I am inclined to put Cheyne-Stokes breathing down as a symptom of grave significance (see also report of 10 cases in *Lancet* March 23, '95, p. 735).

Cardio-vasc. System.—The pulse resembles remarkably the so-called “influenza” type. It is soft, *lacking in tension* and often irregular and sometimes dicrotic. The frequency varies very much within wide limits and seems to bear no relation to the stage or severity of the disease. This is one of the few diseases which with fever the pulse may be exceedingly slow—*e.g.*, 40 per minute or lower, and then it may rapidly change and be 100 or more. The rhythm is constantly changing also. In a case recorded by Wm. J. Class (Brit. Med. J., December 31, '98, p. 1949) the pulse was 80 with a temperature of 105. The patient is frequently cyanosed. Capillary stasis is particularly marked in the fulminant cases, ulcerative endocarditis may occur late. It is not common however.

The red blood cells are pale, shrivelled, serrated and partially broken up. The blood is dark. The number of white cells is increased, and remains high during the whole disease. Reider found 20,100 and 17,500 white cells per c.m.m. respectively in two cases examined. Many of the leucocytes show vacuolation. The haemoglobin is diminished. The *chief increase* of white cells is among the neutrophils and polynucleated: the white cells with a single nucleus are generally diminished. Blood changes are rarer in the *sporadic* cases.

Trophic disturbances, etc.—Sometimes bedsores occur and gangrene has been observed.

Tache Cerebrale may be present as in ordinary tubercular meningitis.

The tongue may exhibit extreme tremor on protrusion. I am not sure whether the early clouding of the cornea should not be ascribed to perverted trophic function of the Gasserian ganglion.

Convalescence: Complications: Sequelae.—Convalescence is generally slow and a relapse is not infrequent. The patient often retains a severe headache long after all the other symptoms have cleared up. For years afterwards he may shew a special proclivity to suffer with repeated headache of a severe type. Neuralgias are common in the abdomen, thorax and legs, and often are very intractable. The patient is extremely emaciated after the illness and is slow in regaining his previous weight.

Respiratory complications which are most frequently met with are pneumonia and broncho-pneumonia. The association of pneumonia with epidemic cerebro-spinal meningitis is claimed by many to be an exceedingly close one. Epidemics of cerebro-spinal fever have often occurred before, during, or after a run of pneumonias in the same locality, and the pneumonia diplococcus has so often been found in cases of cerebro-spinal meningitis that for long they were regarded as diseases caused by the same organism.

Dr. S. Gordon (Reynold's *Syst. of Med.*, Vol. II.) describes oedema of the lung and pulmonary apoplexy. Hydrocephalus is an important complication described by von Ziemssen (*Cyclo. of Med.*, Vol. II) who says it can no longer be regarded as a rare sequel. The ependyma ventriculorum is thickened (Grainger Stewart) and the amount of fluid becomes greatly increased in the ventricular cavities. It is a complication which usually occurs late and is almost always fatal. The symptoms are: persistence of headache with remissions, growing mental weakness and progressive emaciation. Metastatic results from the circulation of the poison in the system are manifested occasionally by ulcerative endocarditis, multiple abscesses and parotitis (Osler: *Pr. of Med.*, p. 100) going on to purulent inflammation.

Paralysis may last for many months sometimes permanently. Baxa (*Weiner Med Presse* No. 29, p. 715) relates the case of a man whose whole left side was paralysed after an attack. See also Omdurman ep. (*Brit. Med. J.*, March 25, '99 p. 769) also Charlewood Turner (*Pathol. Trans.* '84). Paraplegia (Strümpell: *Deut. Arch. f. kl. Med. Bd.* 30) is also recorded. Knee jerks are generally lost in such cases.

Osler (*Boston Med. and Surg. J.*, December 29, '98 and February 16, '99) records cases where there was great pain on passive movement of joints during the illness which remained along with deep tenderness of muscles two months later and which finally developed into spasticity. A case in S. Africa (*Lancet*, November 6, '97, p. 1185) gives evidence of a child who contracted cerebro-sp. fever at 9 years old who subsequently developed pain in the hip, wasting, spasticity of legs and complete rigidity by the time she had reached the age of 19. It seems however doubtful whether this may not have been a case of chronic meningitis rather than epidemic cerebro-spinal fever.

Aphasia has been recorded as remaining for nearly 3 months after onset (Lewis Smith; *Dis. of Children*, p. 370).

The *mental condition* is often deteriorated for a long time. Memory is not as sharp as before the illness: there may be dulness amounting to idiocy.

Paralysis of the bladder was shown in one case of the 1900 Dublin epidemic *Brit. Med. J.*, June 23, '00, p. 1579, by the air whizzing into the bladder while the patient was being catheterised.

The disease is sometimes divided into FOUR STAGES.

The *first* where vomiting and headache are prominent symptoms and the head is retracted. The pulse may be fairly quick in this stage.

The *second* or stage of depression, in which patient is in the dorsal decubitus with tremor of the limbs, and pulse is slow, face pale, and pupils usually dilated, eyes covered with albuminous film, tongue cold and dry. Swallowing difficult.

The *third* stage is often the last and the patient lies in the typhoid state with muttering delirium passing into profound coma and death. Optic neuritis is generally present and the limbs paralysed and cranial nerves affected.

The stage of convalescence may be a *fourth* division of the disease if the patient should recover.

The stages above given are, I think, of very little value as they merge insensibly one into the other and nothing in the symptoms, except the condition of the pulse, affords any specially useful guide in the matter of treatment.

Duration.—Tourdes gives the average duration of the disease as 20 days. It may be as short as 9 hours and as long as 109 days. It varies very much with the type of the epidemic. Hirsch truly says the duration is from a few hours to a few months.

DIAGNOSIS.—The diagnosis rests in main upon the *early and acute* onset of nervous symptoms exhibited in retraction of head, agonising pain in head and spine, succeeded by profound nervous disturbances, as for instance, convulsions and coma. Where the purpuric lesions of the skin are present, accompanied by fever, and the disease is found to be epidemic, the diagnosis is clinched.

We have moreover now a ready method of diagnosis which in a very large proportion of cases yields positive information. By puncture in the lumbar region as advocated by Quinck (*vide infra*, in section on Treatment) or cerebral punc-

ture as performed by myself, some of the spinal or cerebral fluid can be easily drawn off for examination and is usually found to contain the Weichselbaum diplococcus.

It remains present for a considerable period and has been found 7 weeks after onset of the illness.

It may also be recovered from the nasal and pharyngeal mucous and according to Mary Hamilton-Williams is obtainable from the blood. Another point is the presence of Kernig's sign. This valuable aid in the diagnosis seems to have been a good deal overlooked as it is only in the literature of the last five years or so that mention is made of it. It occurs in the vast majority of cases though I failed to obtain it in two cases. I endeavoured to elicit the spasm in the cases referred to within a few hours of onset and possibly the poison had not in that time sufficiently affected the nervous centres involved in the production of the spasm. As the cases proved rapidly fatal it was not possible to repeat the observation.

Früs (Copenhagen) found it in 53 out of 60 cases and Netter (*20th Century Practice* XVI. p. 193 *et seq.*) in 45 out of 50.

If the illness occurs in children it is most likely to be mistaken for tubercular meningitis or pneumonia.

In patients of any age pneumonia, the malignant tertian form of malaria (aestivo-autumnal) typhoid, typhus, acute myelitis, small-pox, scarlet fever, acute otitis (a case given by Leyden in Vol. 6, 1883 *Zeitschrift für klinische Medicin* where acute otitis was diagnosed for several days preceding typical cerebro-spinal fever), insolation, acute spinal meningitis, etc., may come into consideration for diagnosis.

Pneumonia.—The seasonal relationship between the two diseases is very similar in temperate climates. Both often show herpes, both may have moaning respiration, in both leucocytosis occurs (Jaeger in *Zeitschrift für Hygiene*, Vol. 19, 1895). But there is no fever crisis seen in the cerebro-spinal disease as is generally observed in pneumonia. Moreover the typical lung symptoms of consolidation are wanting, though occasionally a fibrino-purulent exudate may be found in the lungs *post mortem* in a case that has died of cerebro-spinal meningitis. The relation of the two diseases is however close and often a bout of pneumonia precedes an epidemic of cerebro-spinal meningitis or follows it. The two are rarely coincident. Leichtenstern (quoted by Netter *20th Centy. Practice*) records in 1885, 63 cases of cerebro-spinal fever and 244 pneumonia but there was not a single instance of complication of one disease by the other.

X The meningeal complications of pneumonia are generally confined to the cerebrum: there may be motor spasm tremors, but rarely nuchal muscular contraction or opisthotonus, according to Osler (*Lancet*, June 24, 1899, p. 1701) herpetic vesicles in cerebro sp. meningitis are often filled with blood, which is distinctly rare in the herpes labialis of pneumonia. There is generally leucocytosis (Osler; *Pr. of Med.*, p. 93) in cerebro-spinal fever which *persists*, as against the absence or *transient presence* of leucocytosis in pneumonia.

Typhoid fever.—Generally the onset is much quieter than the noisy delirious beginning in cerebro-spinal fever. Rose spots and splenic enlargement are usually absent in the latter. The Widal serum reaction and Kernig's sign also help to distinguish the two. The temperature chart does occasionally resemble that of typhoid, though it is rare to have anything like the *classical* "step by step" rise. Muscular tremors, spasms and convulsions occur much earlier in epidemic cerebro-spinal meningitis than in the cerebral typhoid cases.

Typhus.—Here the eruption does not generally appear till the 3rd or 4th day. If it occurs in cerebro-spinal fever it is usually earlier. The much greater contagiousness of typhus is soon evident. The continuously quick pulse, "mousy" smell, and roseolous eruption of typhus are quite characteristic.

Small-pox—The head-ache is frontal and not NUCAL. The characteristic eruption around the roots of the hair first appears on 4th day. Temperature is much higher and the sore throat of the second day of small-pox is absent. The early stiffness and rigidity of neck also serve to differentiate the two diseases.

Tubercular Meningitis has a more insidious onset. The temperature is generally low, it attacks tuberculous subjects and neck stiffness, herpes, etc., are rare. Kernig's sign is but very rarely, if ever found. The hydrocephalic cry, early slow pulse, late appearance of muscular stiffness and the falsely hopeful period of improvement seen in tubercular meningitis are all most characteristic.

Insolation may in tropical countries closely simulate the disease. There is vomiting, often delirium and intense headache. These symptoms resemble those found early in cerebro-spinal meningitis. There is however no occipital retraction. The pupils are not contracted as is generally the case in sunstroke: strabismus is rare: moreover the lower temperature, initial rigors and long duration of the symptoms in cerebro-spinal meningitis serve to place the diagnosis against insolation.

Acute Myelitis soon exhibits girdle pains and paralysis. There is an aesthesia of surface and later atrophy of paralysed parts.

The trophic symptoms, e.g., bedsores are much earlier seen and oftener present in Myelitis and reflexes are diminished or absent contrasting with the exaltation usually found in the meningitis under consideration.

Uraemia with coma, convulsions and muscular rigidity may simulate the symptoms of cerebro-spinal meningitis pretty closely (Murchison) but the temperature is normal and there are no skin eruptions. The patient who is suffering from cerebro-spinal fever experiences such severe head-or spine-ache that even when semi-comatose he often cries out and the facial expression of pain is very evident.

Influenza.—Cases are often recorded where during an epidemic of cerebro-spinal fever persons are seized with sudden severe illness resembling influenza. Sir Wm. Broadbent (Brit. Med. J., Dec. 28, '01, p. 1877) records a case with fatal cerebral symptoms during the epidemic on board H. M. S. *Vincent*. The nervous symptoms in influenza though occasionally very severe are usually late manifestations. The headache though extremely wearying is not usually of the piercing agonising character, nor are the aches found in limbs and spine of the violent excruciatingly painful nature found in epidemic cerebro-spinal fever.

Hysteria.—This has been noted as a disease with which cerebro-spinal fever may be confounded. We find it difficult to imagine any one who has ever seen a case of the more serious malady confounding it even in its milder forms with a hysterical "fit." The rapid improvement, followed by profuse urination of pale water, the history, appearance, and sex of the patient should afford sufficient guides for a correct diagnosis being made.

Weils Disease or Epidemic Cerebral Jaundice.

In an interesting epidemic of this somewhat rare disease, I was greatly impressed with the similarity to Cerebro-Sp. Meningitis. In some cases the cerebellum is involved. In addition to the profound icteric tinge of conjunctivae (which may occur in the meningitis) there may be great retraction of head, fleeting strabismus tenderness of spine Hydrocephalic eye. In all but the System of Med. it is stated that only 10 post mortems are recorded of the disease. I found post mortem in one case that the meningitis of cerebrum was indistinguishable from that I have seen in cerebro-sp. meningitis but the ventricular cavities of brain & central canal of cord were not enlarged, nor was there any increase of spinal fluid. There was no meningitis visible macroscopically of Sp. Cord. The Sp. Fluid was

of a brilliant saffron color. Moreover the other organs, specially bowels, stomach & heart showed similar bright yellow discoloration & there was the usual swelling & stoppage of bile ducts.

Kernig's Sign was not present during life: Knee jerks were diminished & ankle clonus found on one side. I think these points would probably lead one to a correct diagnosis. As the cases have only just occurred I have been unable to get to complete microscopic examination which also would probably help to make the distinction clear between the two diseases.

Retropharyngeal abscess is recorded by Lewis Smith (*Dis. of Children*, p. 390) as simulating cerebro-spinal meningitis. The retracted head and the pain would certainly resemble it somewhat.

We imagine, however, that no other muscular rigidity would be present nor would the characteristic mental conditions of cerebro-spinal meningitis obtain. The difficulty in swallowing would possibly not lead to an intra-pharyngeal examination as it is a common enough symptom in the more serious malady. The slightness of the symptoms and the character of the fever chart would however afford valuable indications.

PROGNOSIS.—The *foudroyant* type is rapidly fatal. Cases in which cerebral symptoms predominate are more serious than those where spinal phenomena are the ones to attract attention. The bullae which sometimes are seen on the skin are of bad omen. I think also that cases beginning violently and shewing Cheyne-Stokes breathing, paralysis of sphincters, oesophageal paresis, immovable pupils, profound stupor and high temperature are to be regarded with the gravest solicitude. In persons beyond 30 years of age where albuminuria is present, the prognosis is very serious.

It is a disease which like cholera should never be absolutely despaired of, as some of the worst cases surprise us by recovery, while on the other hand occasionally a very mild attack rapidly overpowers the patient with apparently an enormous dose of the specific poison.

Those who live till the 12th day or so without serious complications generally recover, provided the heart responds to suitable stimulants.

Mortality.—Hirsch, our best authority on this, who has collected 15,632 cases gives the mortality as 37%. In various epidemics it may vary from 20—~~77~~ 70% (Hirsch). In the epidemic given by Osler, 1898 (*Lancet*, June 24, '99) 76 died out of 111 cases (a mortality of 68·5%).

Wm. J. Class ("*Cerebro-Sp. Fever*") records a mortality of 65% in the epidemic which occurred in Chicago, 1898. In the epidemic at Bayonne in '97 (*Autour d'une épidémie-Delville*) the mortality was 50%.

Where *pain* is a prominent symptom it has been observed that the mortality is low. Possibly this indicates a dose of the poison sufficient only to *irritate* the nervous system, but not sufficely large to cause suppurative and other changes.

TREATMENT.—Prophylaxis.—During an epidemic every unfavourable condition of living should be improved, the streets cleaned, and accumulations of dirt and refuse promptly removed.

Children should especially be guarded from overwork in schools, and kindergartens, and from undue excitement. Fatigue and worry is to be avoided and persons in weak or debilitated health would be well advised, if they left the neighbourhood temporarily. The utmost care may well be taken against any catarrhal condition of nasal or bronchial passages.

Disinfection and Segregation.—Any pocket handkerchief used for the nasal discharge should be promptly put in 1 in 1000 bichloride of mercury solution or in some other way rendered sterile. Wool, &c., used for aural discharge must be immediately burnt.

Though our knowledge is very slight at present as to the means of propagation of the illness (Parkes, for instance (*Pr. Hygiene*, Am. Ed., Vol. II., p. 142) held that the disease is not contagious) it would certainly be good policy to separate the cases from general patients and have them treated in the infectious hospitals: seeing also that the disease is one in which insanitary conditions seem to afford a favourable nidus the locality where an outbreak occurs should be notified to the authorities for disinfection and cleansing. (See *Report of Massachusetts State Board of Health* on Epidemic cerebro-spinal meningitis, for 1898.)

Therapeutics.—The treatment of the disease resolves itself mainly into the treatment of symptoms, as no specific remedy is known.

For the relief of the intense headache, cold compresses are most grateful, or the production of cold by dropping evaporating lotions containing ether or chloroform upon the occiput (Ziemssen). Ice bags may be used, or cracked ice may be mixed with bran or sawdust which retards the melting and also allows a more even distribution of cold to the scalp. This frequently proves one of the best and safest methods of inducing sleep. The scalp may be shaved if the hair is very abundant. Fagge and Pye-Smith relate (*Practice of Medicine*, I., p. 661) a case of remarkable and instant relief from pain by these procedures.

Bags of hot sand, salt or bran, bottles of hot water or hot bricks wrapped in flannel are valuable for counteracting the depressant effect of ice on scalp and spine. They may be applied to the sides of the body, calves of the legs and soles of the feet. Hot baths are said to have a calming quieting effect (Jewnin—*Therap. Monatshefte*, 1896, Heft 11, S. 581.) Continuous dry heat is advocated by several American physicians. The Japanese hot tins are handy in this method and secure the application of an even heat for several hours consecutively. Mildly stimulating liniments e.g., Lin. Camph. Co., with turpentine, to the spine are sometimes of benefit. Sutton (quoted by Lewis Smith, *Dis. of Children*, p. 395) advised it soaked in a strip of flannel and put on spine and then ironed up and down with a hot laundry smoothing iron.

Stimulating enemata are often of considerable service (Hare's *System of Therapeutics*, II., p. 411).

Blisters have received the approval of no less an authority than Stillé. They seem, however, to have but little beneficial effect over the disease and certainly aggravate the patient's discomfort; if used however a long narrow strip of blistering plaster may be put along the upper half of spine as recommended by Guy and Harley in their "Physicians' Vade mecum" (10th Edition, p. 276).

Dry cupping over the neck relieves the nuchal pain in some patients. Stimulating applications in form of ointments or liniments may be tried behind the ears, or leeches (several, if used at all) put over mastoid regions. Of drugs there is a very large number used.

Opium is *the remedy par excellence* and it is very interesting to see the heroic doses which patients stand without its producing any soporific effect. It receives Shoemaker's warm commendation (*Mat. Med.*, p. 786) among many other well known therapeutists. Haskell has given 10 grain doses in violent cases without producing stupor. The ordinary dose is 1 to 1½ gr. every hour in the worst cases, or every 2-3 hrs. in milder cases. It calms the patient, quiets the convulsions, and relieves the pain and distressing insomnia.

I have found morphia a better method of administration, as it avoids the risk of the drug being vomited. Niemeyer also recommends it ("Die hypodermatische

Injection," p. 156) specially in early irritative stage. (Bartholomew^w: "*Hypodermic Medications*", 1891, p. 225). It may be continued advantageously with atropine in spite of a few writers who decry the use of either atropine or belladonna in the disease. Whitla (*Dict. of Treatment*, p. 501) suggests antipyrin and exalgine for the pain.

Sulpho-carbolate and hyposulphite of Soda are thought by Carmichael (*Dis. of Children*, p. 101) worthy of trial. The same author recommends hourly or two-hourly doses of Liq. Ferr. Perchl. and Liq. Hydrarg perchlor 5 minims, each with a dram of glycerine, and 2 drams of water.

Abercrombie (*Dis. of Brain and Sp. Cord*, 3rd Ed., p. 155) advocated free purgation with croton oil.

Cannabis Indica (or Urethane 5-10 grains) palliates the nocturnal delirium and insomnia.

Rummal recommends digitalis, Kirchof, zinc oxide. Bromide of potassium is reported on very differently. Loomis (*Practical Med.*, 1892, 8th Ed., p. 721) says it is specially beneficial given to children, while the Vienna authorities (Rosenthal and others) say it is of very slight, if any, value in true ep. cerebro-sp. meningitis. If given it must be in large enough doses to control the spasm.

Carmichael (*Dis. in Children*, p. 100) gives it in 5 gr. doses every hour or two, and seems to favor its use, certainly for children.

Quinine. This is a drug on which opinion is much divided as to its use or applicability in such a condition as epidemic cerebro-spinal meningitis. Hirsch, Ziemssen, Griesinger and Mannkopff all report favourably on its use. (Quoted by Rosenthal in his *Dis. of Nerv. Syst.*, p. 31). It is surely rarely needful to secure its beneficial effects (if any) by the heroic doses of 3-4 grammes (45 to 60 grains) as is given by some of the German physicians.

Ergot has been given in large doses and I think with sufficient success to justify its further and more extensive trial. It is used by such a careful and observant physician as Dr. Wm. A. Thomson (Prof. Bellevue, Med. College, N. Y.) who employs dram doses of the liquid extract even to a child of ten years old, in the early inflammatory stage, or 2-3 grains of Ergotine may be given hypodermically.

Hanuschke and Rémy recommend moderate abstraction of blood by leeches, wet cupping or venesection (*Pediatrics*, June 15, '98). The same author suggests tincture of iodine applied to the spine.

Calomel is usually given and certainly if the patient is constipated the bowels should be kept open though mercury is now no longer believed to have any specific action on the course of the illness.

Potassium iodide has been given with the idea of assisting the absorption of inflammatory products (*J. Am. Med. Association*, Sep. 24, '98). It is claimed also that it prevents hydrocephalus, attributable to pressure of effused lymph on cerebral veins. It is doubtful in the absence of further pathological evidence on the causation of hydrocephalus whether such an opinion is tenable.

Subcutaneous injections of corrosive sublimate are recommended by Bela Angyan (*Ind. Med. Gaz.*, Mar. 1899).

Belladonna has been reported on favourably by a few and Fl. Ext. of Gelsemium is said by Bartholomew^w to be serviceable.

Calabar bean has been recommended by S. N. Davis (*Louisville Med. J.* XIII—711) and Miller (*Brit. Med. J.* July 1, '99 p. 22).

Ung. Créde (a soluble metallic silver preparation) is highly vaunted by Gustav Schirmir (*N. Yorker Medicinische Monatschrift*, 1898, Vol. 10, No. 11) 1 oz. being rubbed into the skin daily for 3 days, then the amount reduced to one-third. Alcohol may be pushed to extreme limits and is well borne and seems beneficial in cases where the nervous exhaustion and threatened cardiac failure is profound. Arnel states he has given a quart of brandy in 6-8 hours with good result. Such quantities should only be given in the *extremely exceptional* circumstances as the reaction is powerfully depressing to the vital functions.

In convalescence iron and arsenic and infusion of some bitter as quassia is indicated. In 12 cases treated at Marmorek (Jerusalem) with antistreptococcic serum all recovered. I have no personal experience of this as though I was anxious to try it and sent for some serum. I was unable to obtain it in time for use. Mc. Nabb (*N. York Med. J.*, Feb. 25, 1899) recommends it also.

Laminectomy has been performed with drainage of spinal canal, (*Lancet*, Ap. 1, '99 and *Boston Med. and Surg. J.*, Dec. 29, 1898) and Quinck's puncture performed for confirmation of diagnosis has often distinctly relieved the paralytic symptoms though in the absence of drainage the symptoms have afterwards returned.

The needle of a large antitoxin syringe should be pushed into the spinal canal above the 4th lumbar vertebra. In children it can easily be passed in the median line, in adults somewhat to the side. In an account of the technique given in Neuraths "Referat" (*Centralblatt für die Grenzgebiete der Medizin und Chir.* Band I) it states that the spinal fluid is generally clear to the 2nd interspace and turbid below that point. The effects of the puncture are certainly transient. I am inclined however to put it down as one item in the treatment of the disease as in a case of my own, I saw remarkable alleviation of the distressing pain, within 15 minutes of the fluid being drawn off (about 10cc). Cuthbertson (*Chicago Med. Recorder*, June 1899) gives a striking example of recovery after lumbar puncture.

This is one of the diseases which depend very much on careful nursing. The ice bags or cold compresses must be looked after and punctually renewed. The hot bags, etc., must be sufficiently protected to prevent the patient being burned during his unconscious or comatose state. The medicines must be regularly administered and the patient skilfully watched for early signs of coma, respiratory difficulty, failing pulse or hyperpyrexia. The room should be darkened, cool and quiet. No unnecessary attendants should be permitted on any pretext and the patient must be protected from every needless excitement or noise. If the traffic is disturbing, straw or tan must be immediately put down opposite the house and extending (an important point often forgotten) sufficiently far each way to prevent the patient hearing any of the coming or going vehicles.

The food must be light and easily assimilated. Peptonised milk, jellies, strong broths, meat extracts, iced blanc manges, are indicated. Sometimes well made ice cream is easily taken and if really made of cream contains a good deal of nutriment. Raw beef juice, barley water, chicken and beef jellies are useful.

I have found it needful in some cases to feed by the nose tube, which is easily passed if lubricated with olive oil. Glycerine is an exceedingly bad lubricant if it is passed through the nose, as it is certain to set up a catarrhal condition of the nasal mucous membrane.

Nutrient enemata may be added if needful.

Alcohol in the form of port wine is sometimes needed for a few weeks after convalescence. It is doubtful, however, whether in the recovery from a profound poisoning of the nervous system it is good practice to prescribe alcohol unless there are specific indications for so doing.

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In this last list I have only noted such authorities which were not referred to in the previous list as having been consulted :many of which were also quoted by various writers.

This is to certify that the above thesis is entirely my own work.

(Signed.)

J. Putter Williamson.